

A large, stylized globe with a grid of latitude and longitude lines is positioned on the left side of the slide. A white contrail from an aircraft is visible in the upper left quadrant of the globe.

Cockpit Display of Traffic Information (CDTI) Enhanced Flight Rules (CEFR)

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Overview

- Review of Cockpit Display of Traffic Information (CDTI) and CDTI Enhanced Flight Rules (CEFR)
- CEFR Concept Examples
- CEFR Purpose
- Simulations
 - Purpose
 - Participants
 - Simulation Environment
 - Procedure
 - Initial Pilot Questionnaire Results
 - Future work
- Issues

Acronyms

- ATC – Air Traffic Control
- CDTI – Cockpit Display of Traffic Information
- CEFAR – CDTI Enhanced Flight Rules
- FAF – Final Approach Fix
- ILS – Instrument Landing System
- IMC – Instrument Meteorological Conditions
- IFR – Instrument Flight Rules
- MVA – Minimum Vectoring Altitude
- PFOV – Primary Field Of View
- TQ – Throttle Quadrant
- VFR – Visual Flight Rules
- VMC – Visual Meteorological Conditions

CEFR

(In early stages of development)

- What?
 - Visual separation including the CDTI, i.e., CDTI is authorized for use in lieu of visual out-the-window contact (ASAS Application Category: Airborne Separation)
 - Operational changes from current procedures are the use of flight identification, when appropriate, during traffic advisories and the flight crew use of the CDTI to maintain visual contact with the traffic to follow
- Where?
 - Terminal Area - Class B or C airspace
- Why?
 - To increase capacity under deteriorated weather conditions
- When?
 - An inability to continue the conduct visual approaches but weather at least VMC (1000 ft & 3 miles)
- Who?
 - Safe Flight 21 & RTCA SC-186 WG 1

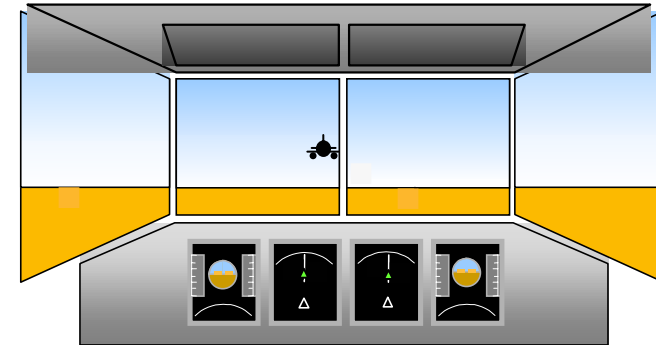
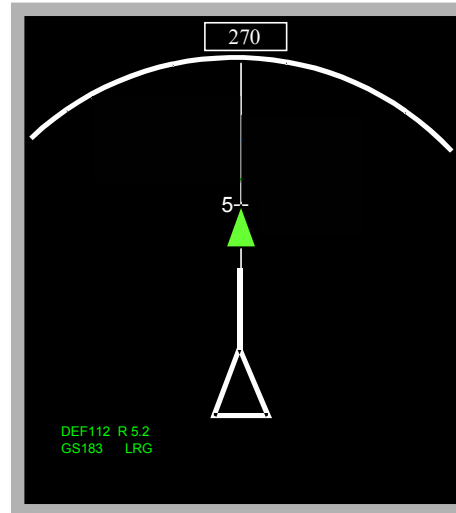
CDTI



IMC CEFR Concept Example (1 of 3)

Initial Visual Acquisition

- ATC provides traffic advisory with call sign
- Initial visual out-the-window (OTW) acquisition, correlation with CDTI
- Clearance to maintain “visual” separation prior to loss of visual OTW
- Cleared for ILS



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FAF

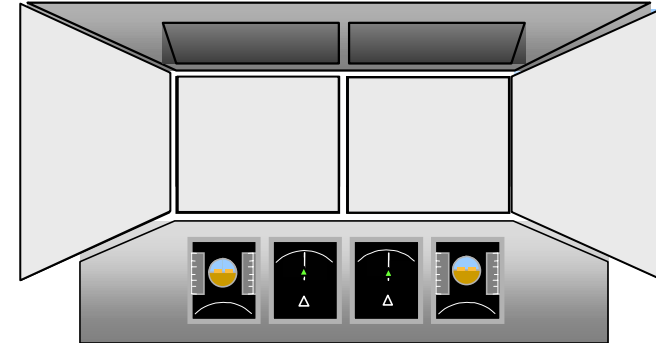
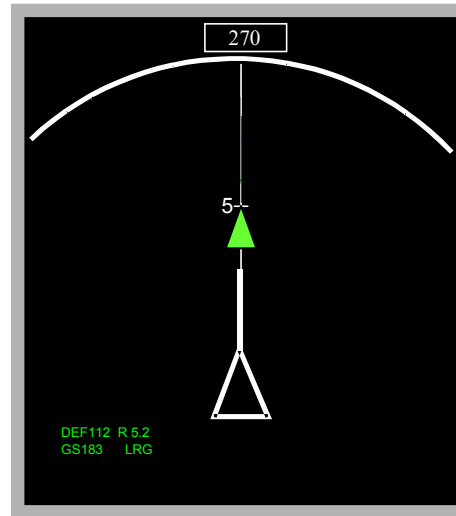
Call Sign Use

- **Louisville Approach:** “Abaco 235, Louisville Approach, traffic 12 o’clock, 6 miles, southbound, Boeing 737, 4000, Defiant one twelve.”
- **Abaco 235:** “Louisville, Abaco 235, Defiant one twelve is in sight.”
- **Louisville Approach:** “Abaco 235, maintain visual separation from Defiant one twelve.”

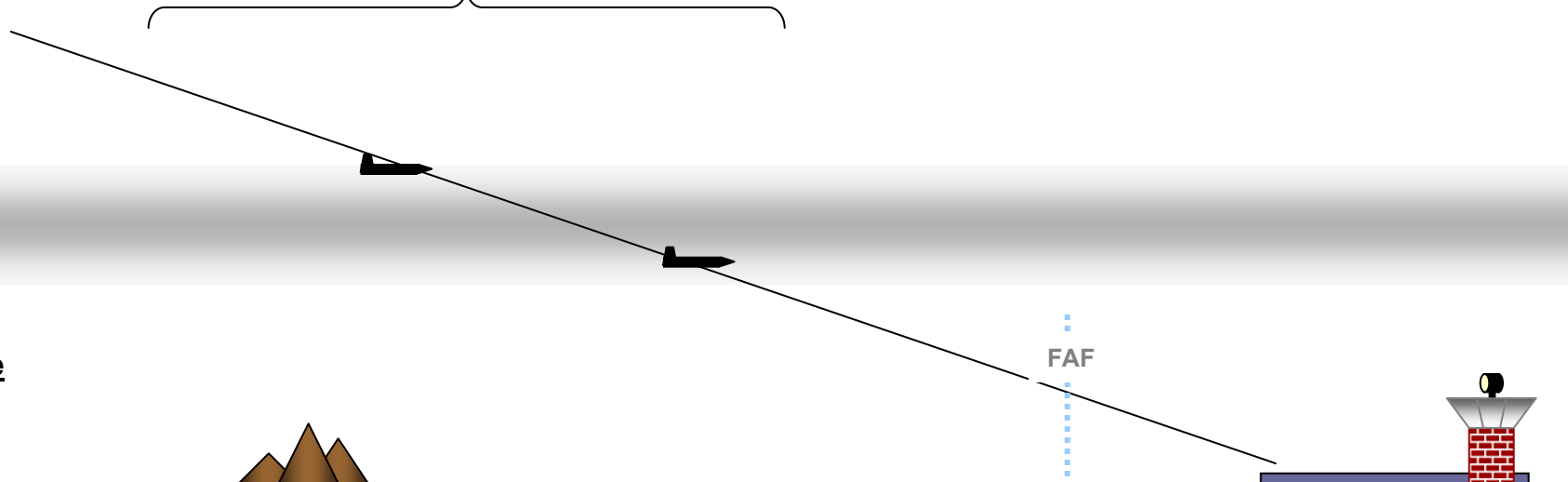
IMC CEFR Concept Example (2 of 3)

Time on CDTI

- Once lead aircraft enters the clouds, CDTI is used for separation
- Time on display begins when lead enters cloud and ends at ownship transition to visual



Time on display

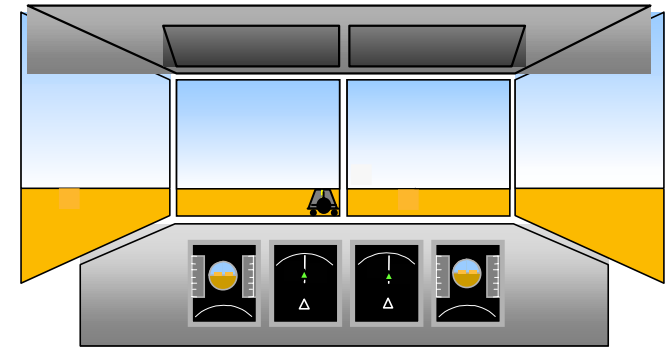
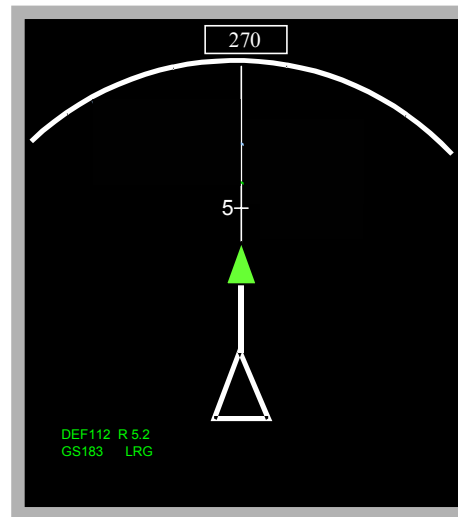


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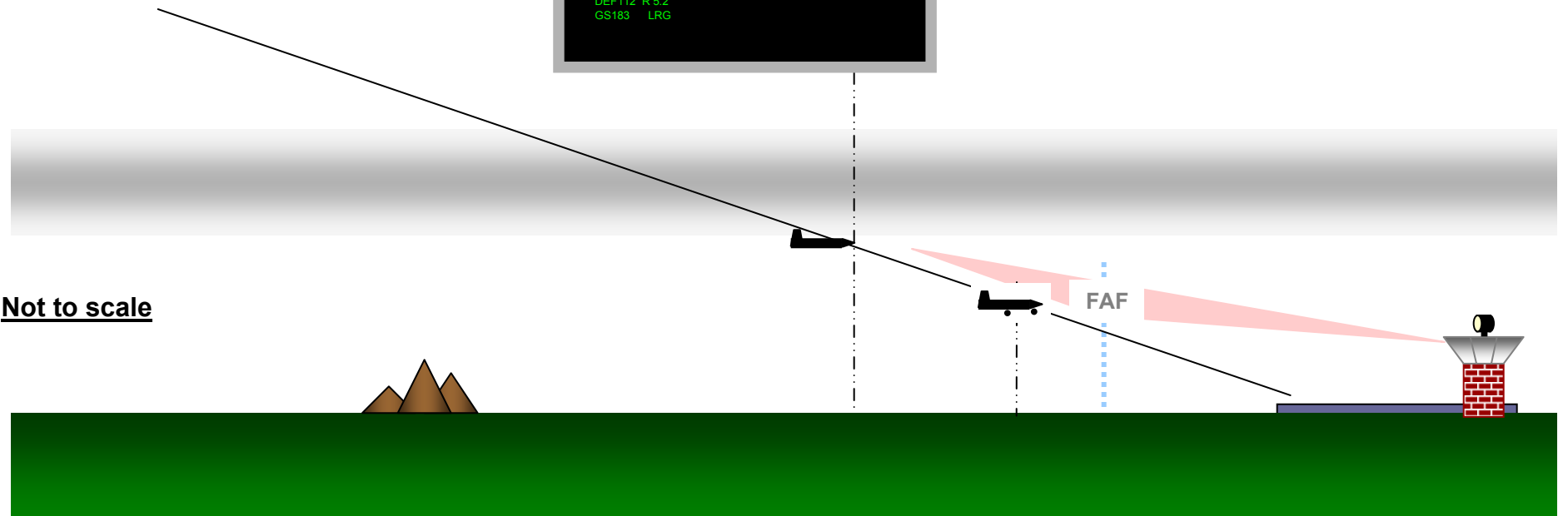
IMC CEFR Concept Example (3 of 3)

Visual Re-acquisition

- Continue to normal landing, using both visual and CDTI information

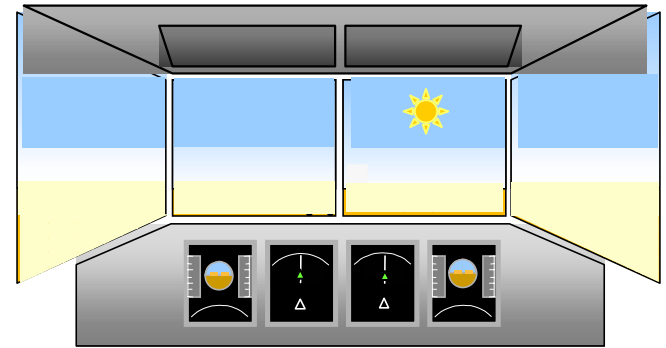
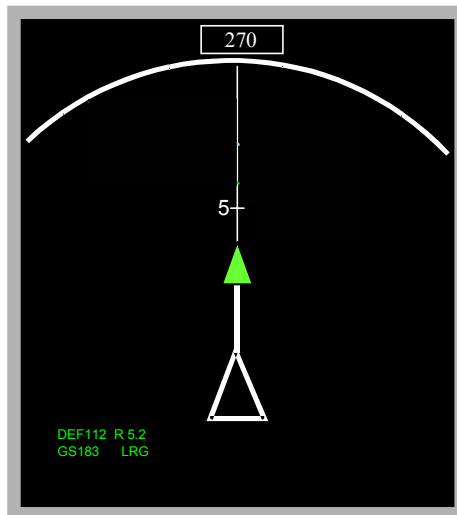


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VMC CEFR Concept - TBD

- CDTI use during periods of lost visual contact
 - Haze
 - Sun
 - Reduced visibility
- Pilots need to see terrain

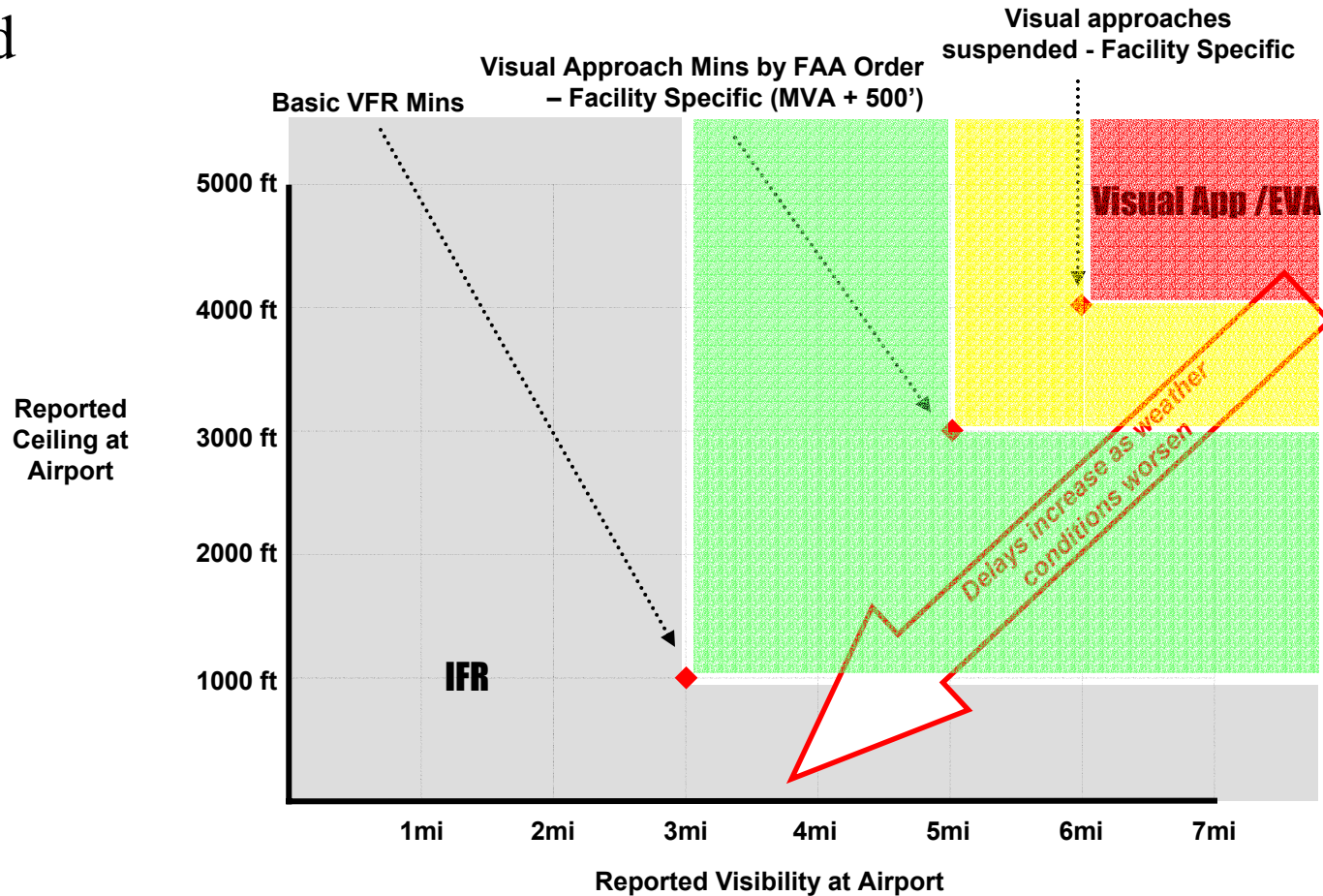


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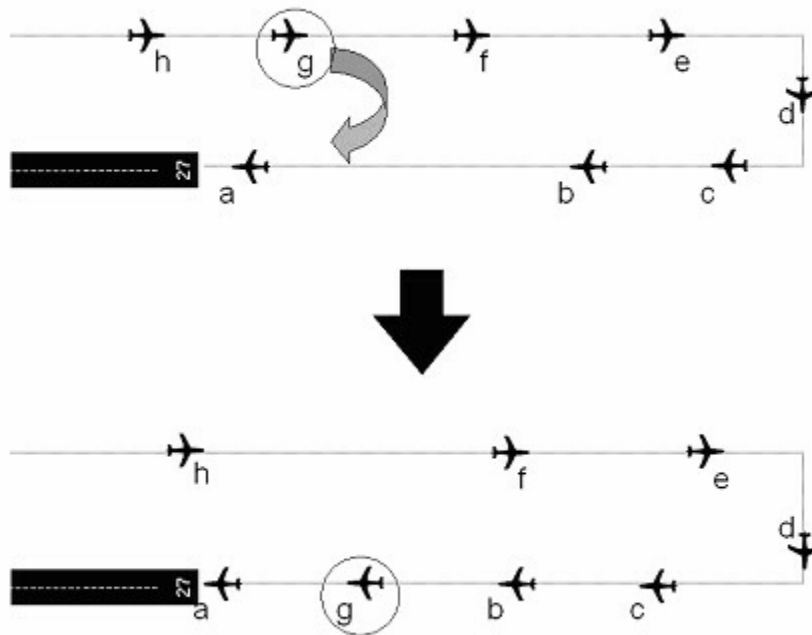
CEFR Purpose (1 of 3)

Increased
capacity



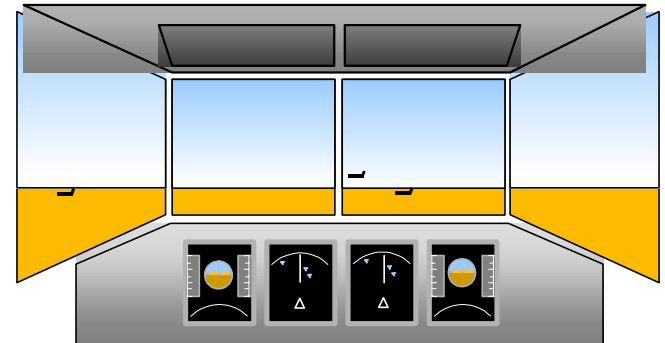
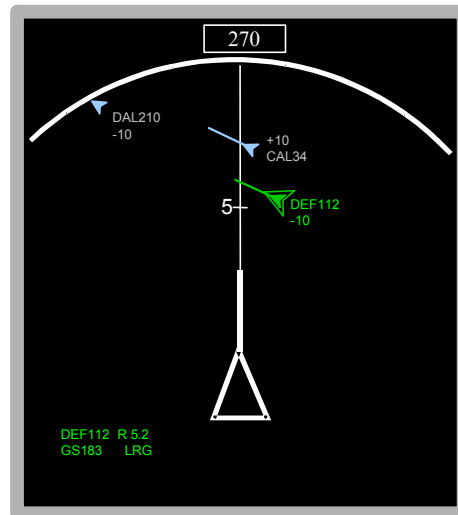
CEFR Purpose (2 of 3)

Controller flexibility



CEFR Purpose (3 of 3)

Increased pilot situational awareness when conducting visual approaches in marginal conditions

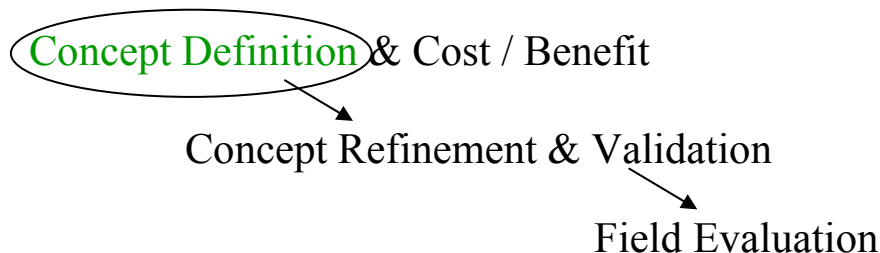


Initial Simulations

May and July 2002

Purpose of the Simulations

- Evaluate CEFR concept from pilot perspective
 - Procedure
 - Display features
 - Display location & size
 - Acceptance
 - Performance
- Initiate ATC into the simulations
- Develop the operational concept
- Conduct medium fidelity simulations leading to high fidelity simulations and flight testing
- Conduct medium fidelity simulations supporting the **Concept Definition** phase

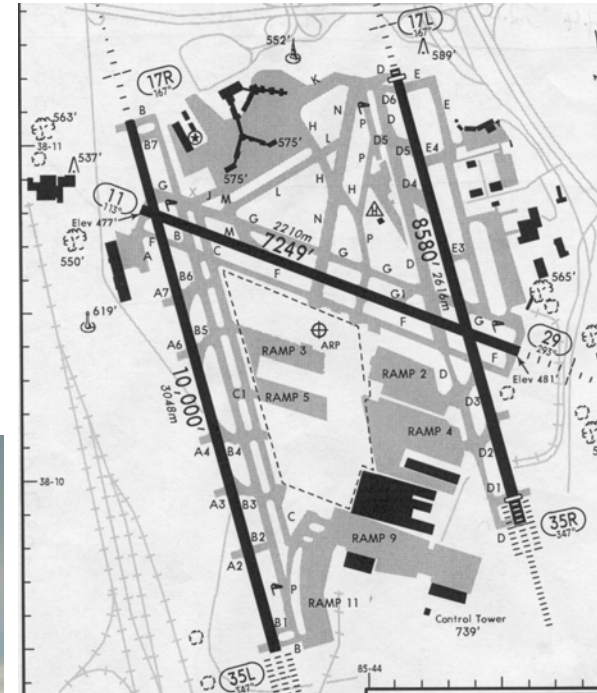


Participants

- Pilot subjects
 - Required ≥ 100 hours part 121 “glass” cockpit experience
 - Required TCAS experience
- 1 simulated (May) or 2 confederate ATCs (July)
- 1 confederate Pilot Not Flying (PNF)
 - PNF duties included normal callout, etc
- Pseudo pilots
 - “Fly” other aircraft in the simulation
- 1 cockpit simulation observer (NASA AMES)
 - Data collection

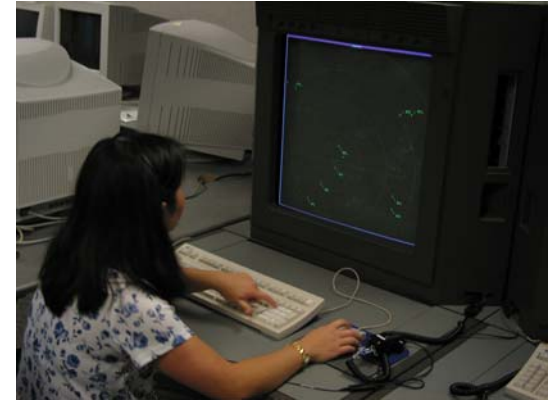
Simulation Environment (1 of 2)

- Louisville International Airport (SDF)
 - Traffic on approach
 - 17L – Independent flow of traffic
 - 17R – Ownship + other traffic
 - Independent approaches
 - Not replicating exact operations at SDF



Simulation Environment (2 of 2)

- ATC Terminal Radar Approach Control (TRACON)
 - Automated Radar Terminal System (ARTS) III-like
- Generic medium fidelity twin jet aircraft
 - Autopilot used for flight control
 - Coupled ILS (i.e., use of approach mode)
 - Auto-throttle to control speed for spacing



Experimental Procedure (1 of 2)

	May	July
Independent Variables	Cloud Thickness / Time on CDTI & Spacing Assignment	CDTI size & CDTI location
Participants	Subject Pilots Scripted ATC	Subject Pilots Confederate ATC
Complexity	Scripted Scenarios	Less Scripting
	No Wind	No Wind
Lead aircraft	Large Aircraft Only	Large, 757, & Heavy
Initial Position	Final Only	Final, dogleg to final, & downwind
Traffic Pattern	Generic Final	Generic patterns
CDTI Location	Primary Field of View (PFOV)	PFOV & Throttle Quadrant
CDTI Size	Large (~ 8 inch diagonal)	Large (~ 7 inch diagonal) Small (~ 6 inch diagonal)
Approaches	18 ILS (single stream)	12 ILS (single stream)
Flight Control	Coupled Approach & Autothrottle	Coupled Approach & Autothrottle

Experimental Procedure (2 of 2)

- Pilot training & familiarization
 - Consent form & pre-questionnaire
 - Introductory briefing
 - CEFR and CDTI briefing
 - Workload measure familiarization
 - Practice approaches (including one missed approach / go-around)
- Simulation / Data collection
 - ILS approaches
- Pilot debrief
 - Questionnaire regarding CDTI, procedure, head down time, acceptance, simulation environment, etc
 - General discussion

Initial Pilot Questionnaire Results

Results Overview (1 of 4)

- Pilots were comfortable with the simulation environment and their ability to perform the procedure in the simulator



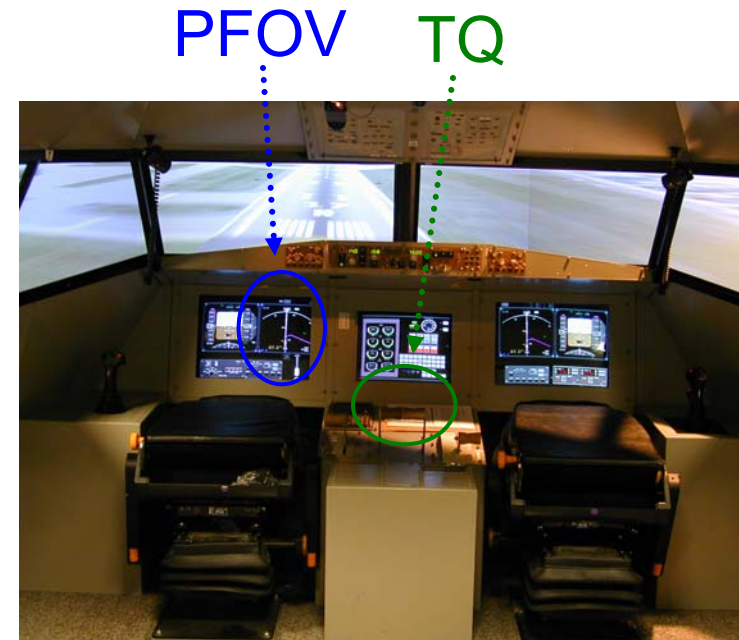
Results Overview (2 of 4)

- Pilots were comfortable with the use of the CDTI for spacing and the CEFR concept
 - More confident in the use of the CDTI as compared to using out-the-window visual cues for establishing appropriate spacing
 - Willing to accept separation responsibility from the traffic to follow by reference to the CDTI
- Pilots were comfortable with the CDTI feature set



Results Overview (3 of 4)

- Pilots preferred the **PFOV** over the **TQ** location. However, they indicated that they would fly the procedure with any of the sizes or locations presented
 - More variability in the **TQ** CDTI responses
- Pilots were comfortable with use of the use of CDTI for separation during the cloud layers experienced (500, 1500, 2000, 4000 ft)



Results Overview (4 of 4)

- Pilots indicated that the benefits involved in the use of call sign in traffic advisories were worthwhile and that it aided in the positive identification of aircraft
 - However, pilot opinions were in opposition on the actual use in replying to ATC and any associated confusion

Future Simulation Work

- Analysis of objective data
- Analysis of workload data
- Analysis of open ended questionnaire data and debriefing comments
- Completion of May and July simulation final reports
- Future simulations
 - November 2002
 - Further develop the concept
 - Examine visual approach procedure
 - Examine increased workload through manual vs. autothrottle speed control
 - Introduce SDF ATC into simulations
 - Winter / Spring 2003

Issues

Technology doesn't appear to be an issue. Acceptance could be.

- Can the pilot use the CDTI in lieu of visual sighting?
 - Need: FAA Flight Standards, pilot, & union approval
- ATC would like CEFAR to be very similar to visual approach, i.e., transparent to ATC. Can this be done?
- Avoidance of wake turbulence while using CDTI only
 - When using CDTI only, out the window visual cues lost
 - Does a “hard” limit need to be set that the pilot will not exceed or can it be provided as guidance
- Is a cockpit-based spacing alert required?
- Can CEFAR be conducted for parallel runway visual approach operations?
- Mixed equipage environment

Further Information

- For further information on the concept or the simulations, contact:
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